SEISMOLOGY ON VENUS THROUGH BALLOON AND ORBITER-BASED REMOTE SENSING. S. Krishnamoorthy1, A. Komjathy1, J. A. Cutts1, M. T. Pauken1, D. C. Bowman2, R. F. Garcia3, D. Mimoun3, J. M. Jackson4
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Introduction: The study of a planet’s seismic activity is critical to the understanding of its internal structure. Tectonic structures showing lateral strain cross-cut the Venusian surface, suggesting recent deformation and potential for ongoing seismic activity [1]. Thousands of shield volcanoes, shield fields, and domes have also been seen on the surface [2]; weathering of olivine on Venus seems to suggest present-day volcanism as well. Extremely high temperature and pressure conditions on the surface of Venus [3] present a significant technological challenge to performing long-duration seismic experiments similar to those being performed by the InSight lander on Mars. Therefore, despite multiple visits from several landers, the internal structure of Venus still remains a mystery. Seismic disturbances are known to generate infrasonic (frequency < 20 Hz) waves by coupling energy from ground motion into the atmosphere. These waves have been detected from earthquakes and volcanic activity from terrestrial stations on Earth [4, 5]. Seismic infrasound may also be detected from balloon-borne pressure sensors [6, 7] and from orbit through the interaction of pressure waves with the airglow layer [8]. The intensity of seismic infrasound generated depends strongly on the relative density of the atmosphere and the planet’s crust. Here, Venus offers a unique opportunity – due to its dense atmosphere, energy from seismic activity couples with the Venusian atmosphere up to 60 times stronger than Earth [9]. These results offer a unique opportunity to explore the internal structure of Venus using balloons floating in the mid and upper atmosphere and orbiters in a high Venus orbit, without needing to land and survive on its surface for long durations.

Advances in balloon and orbiter-based seismology: In order to achieve the aim of performing geophysical experiments from an atmospheric platform, we are developing technologies for detection of infrasonic waves generated by earthquakes from a balloon in the Earth’s atmosphere, thereby using the Earth as a Venus analog. By closely studying infrasound generation and propagation in the Earth’s atmosphere, we can develop tools and methods that will allow for the detection, location and characterization of venusquakes from a balloon floating in the relatively benign conditions in its upper atmosphere.

In addition, we have studied the generation of thermal fluctuations from seismic activity in the 1.27 µm night-side airglow and 4.32 µm day-side bands on Venus as a means to detect seismic activity. This study culminated in the formulation of the Venus Airglow Measurements and Orbiter for Seismicity (VAMOS) mission concept, which showed that venusquakes of magnitudes above Mw 5.3 can be feasibly detected and characterized from a high, circular Venus orbit capable of viewing the planetary disk [8].

Presentation Content: In this presentation, we will present advances made in the past year in developing techniques for balloon and orbit-based seismology on Venus. We will provide detailed analysis from various field campaigns and significant results for the balloon and orbiter-based seismology concepts. We will also discuss relative strengths and weaknesses of these two techniques and highlight the complementarity that exists between these two approaches. Finally, we will share our vision for the future of these techniques and their path to infusion into a Venus mission.

References:


